APPLICATION UNDER UNITED STATES PATENT LAWS

Atty. Dkt. No.   PM 273212
(M#)

Invention: METHOD AND SYSTEM FOR ADAPTIVE PRODUCT RECOMMENDATIONS BASED ON MULTIPLE RATING SCALES

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SPECIFICATION

METHOD AND SYSTEM FOR ADAPTIVE PRODUCT
RECOMMENDATIONS BASED ON MULTIPLE RATING SCALES

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BACKGROUND OF THE INVENTION

Field of the Invention

15   The present invention relates in general to e-commerce. More specifically, it relates to an arrangement that recommends products to users by matching specified properties of products, indicated by users as being desirable, with the properties of available products.

General Background and Related Art.

20   E-commerce via the Internet is becoming ubiquitous. More and more business transactions are conducted directly on the web. Individual shoppers are switching on-line shopping at a rapid rate. A user can browse the web site of a particular manufacturer for available products and make purchases if satisfactory products are identified. A user can also browse the web sites of on-line shopping service providers that consolidate products from

25   different manufacturers and make them available for purchase via a single web site. In this

latter case, a user is able to browse much larger variety of products with usually a bigger

selection pool and price variations for individual types of products.

One factor associated with the service quality of on-line shopping is how efficiently a

shopper can make a selection of a desired product. This is particularly crucial for web sites

5 that provide a large variety of products. While it may be beneficial for a user to be offered a

big selection of products, the burden on the user to make a selection is increased. Various e-

commerce systems deploy automated product recommendation systems to help a shopper to

make a product selection more efficiently.

In a product recommendation system, products may be characterized as to one or more

10 attributes. The characterization of products can be utilized to help users to make product

selections. For example, books may be classified into various categories according to the

subject of the book. For instance, a book may be characterized as a history (a category) book.

By acquiring a user's specification (or characterization) about his/her desired book in terms of

known book categories, a list of books may be identified that fit the user's characterization of

15 the desired product. This list of books forms a product recommendation that is consistent

with the user's desires. Equally importantly, the recommendation substantially reduces the

selection pool so that the user can make a final choice based on a smaller amount of, yet more

relevant information.

Existing product recommendation systems use overall rating information to

20 characterize a product. For example, a product may be associated with a score that reflects

the popularity of the product, measured by, for instance, how many people have purchased the

product. In such a measure, a user's purchasing of a product is equated with the user's liking

of the product.   This may not be necessarily true, though.   So, such overall rating information

does not reflect the feedback from product users.

In addition, such overall rating information is one-dimensional.   An overall rating

may be indicative in a general sense, but it offers no specifics about, for example, what

5   aspects of a product lead to a low or high rating, which can be very useful information to a

shopper. For example, if a movie is rated very popular, there is no way of knowing, from an

overall popularity score, whether the popularity is due to the actions in the movie or due to

the artistry of the movie.

There is a need for a product recommendation system that recommends products

10   according to product characterizations using multiple rating scales and that adapts by self-

calibrating the system based on users' feedback acquired from product users.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is further described in the detailed description which follows, by

15   reference to the noted drawings by way of non-limiting exemplary embodiments, in which

like reference numerals represent similar parts throughout the several views of the drawings,

and wherein:

Fig. 1 shows a high level block diagram of an illustrated embodiment of the present

invention;

20   Fig. 2 is an exemplary flowchart of a process for recommending a product with self-

calibrating capability;

Fig. 3 shows an exemplary rating scale;

Fig. 4 shows an exemplary rating on multiple scales;

Fig. 5 shows an exemplary flowchart of a process for acquiring post-use multiple-scale

ratings across a set of products;

Fig. 6 shows an exemplary expanded functional block diagram of an embodiment of

the present invention;

5   Fig. 7 shows an example, in which a rating score with respect to a particular rating

scale is calibrated based on post-use ratings from users;

Fig. 8 shows an exemplary flowchart of a process for updating a multiple-scale rating

of a product based on post-use ratings from users;

Fig. 9 shows an example, in which a personalized filter is generated based on the

10   discrepancy between a user's pre-use product selection specifications of desired products and

the user's post-use ratings on the recommended products;

Fig. 10 shows an exemplary flowchart of a process for generating a personalized

multiple-scale filter;

Fig. 11 shows an example, in which causes of users' dissatisfaction are identified

15   based on post-use multiple-scale ratings; and

Fig. 12 shows an exemplary flowchart of a process for generating an adjustment filter

used to adjust the importance of rating scales.

DETAILED DESCRIPTION

20   An embodiment of the invention is described with reference to the drawings to

improve upon known product recommendation arrangements by enabling product

recommendations based on adaptive multiple-scale ratings. The illustrated embodiment

allows a product recommendation system to self-calibrate multiple-scale ratings according to post-use multiple-scale ratings from users of the recommended products.

Fig. 1 is a high level block diagram of a multiple-rating-scale based product recommendation system 100. The illustrated product recommendation system 100 comprises

5   a pre-use product selection specification acquisition unit 110, a post-use multiple-scale rating acquisition unit 130, a product recommendation unit 150, a calibration unit 160, and a product multiple-scale rating storage mechanism 170.

In Fig. 1, pre-use product selection specification acquisition unit 110 acquires a user's input, prior to making a product recommendation. The user's input specifies the properties of

10   the product that the user desires. In a product recommendation system, products may be rated according to some criteria. Such rating information is stored in product multiple-scale rating storage mechanism 170 and is accessible to product recommendation unit 150. A pre-use product selection specification may be constructed with respect to the rating scales used in product ratings so that the selection specification can be used to match with corresponding

15   product ratings to select the products whose ratings are similar to what a user desires.

In the illustrated embodiment of the present invention shown in Fig. 1, the rating for each product is multiple-scaled and may be represented as a set of scores or a vector. Storage mechanism 170 is capable of storing, randomly access or retrieving multiple-scale rating information.

20   Product recommendation unit 150 makes product recommendations to a user based on the pre-use product selection specifications, acquired from the user, and current multiple-scale rating information of products, retrieved from product multiple-scale rating storage mechanism 170.

In the illustrated embodiment of the present invention, users' feedback on the recommended products may be acquired after the recommended products have been tried. Such feedback is obtained in the form of post-use ratings that may also be multiple-scaled. The scales used in post-use ratings may correspond to the scales used in current product

5   ratings. The post-use ratings may be utilized to re-calibrate current product ratings. In Fig. 1, post-use multiple-scale rating acquisition unit 130 acquires post-use multiple-scale ratings from users. The post-use multiple-scale ratings are fed to calibration unit 160 to re-calibrate the current multiple-scale product ratings, Calibration unit 160 may also use pre-use selection specifications for calibration purposes. The calibrated results may be saved in product

10   multiple-scale rating storage mechanism 170.

Fig. 2 is an exemplary flowchart for system 100. A pre-use multiple-scale selection specification is first acquired from a user at act 210. Pre-use refers to the fact that the specification is given prior to the use of a product. A pre-use selection specification defines the properties of a desired product. For example, a user may indicate, through a pre-use

15   selection specification, that the desired product has an overall rating above 7, out of a scale from 1 to 10. A multiple-scale selection specification defines more than one property of the desired product. For example, a user may look for a desired movie (a product) in terms of amount of action in the movie, whether it is a drama (as opposed to comedy movie), and the overall rating of the movie.

20   Once a pre-use product selection specification is acquired, current product rating information is retrieved at act 220 from product multiple-scale rating storage mechanism 170. Based on both the pre-use product selection specification, acquired at act 210, and the current product multiple-scale rating information, retrieved at act 220, product recommendation unit

150 makes a product recommendation at act 230 by selecting one or more products whose multiple-scale ratings are substantially similar to the pre-use product selection specification. The recommended products are used or tried at act 240 by the user. After the use of the recommended products, post-use multiple-scale rating acquisition unit 130 acquires feedback

5   at act 250 from the user. A post-use multiple-scale rating may include rating scales that correspond to the rating scales used in current rating for products. Based on post-use multiple-scale ratings, calibration unit 160 performs various analyses at act 260. Such analyses may be carried out in relation to the corresponding pre-use selection specifications. Calibration unit 160 further performs calibration of current multiple-scale product ratings at

10   act 270.

Each scale used in a multiple-scale rating may correspond to a specific product property. The rating with respect to a specific scale or product property may be specified as a score within a certain range. Such a range may be defined by two numerals or by two semantic differential words. Fig. 3 shows an exemplary rating scale with a range defined by

15   two semantic differential words. The scale shown in Fig. 3 applies to movie products and the two semantic differential words are comedy and drama, that define the two extremes on the scale. A movie can be rated on this particular scale through a rating score. The rating score on a scale may be determined, as illustrated in Fig. 3, by the position of a slider on the scale. When the two semantic differential words of a range are translated into numerals, any position

20   within the range may be translated into a numerical score.

In a multiple-scale rating scheme, each product is rated with respect to a plurality of scales. Fig. 4 shows an exemplary multiple-scale rating for movie products. In Fig. 4, top scale is formed by semantic differential words comedy and drama, next scale is formed by

semantic differential words modern and period, and the bottom scale is formed by semantic differential words adult and family. Each product is rated on every scale and the ratings from all the scales form a multiple-scale rating of that product. For example, in Fig. 4, all the solid (black) slider positions form a multiple-scale rating for a particular movie. The hollow slider

5   positions correspond to a multiple-scale rating for a different movie.

When acquiring a pre-use selection specification, pre-use selection specification acquisition unit 110 may present multiple scales to a user and let the user to determine a slider position on each scale. The acquired set of slider positions forms a multiple-scale selection specification which can be used to compare with the slider positions or multiple-scale ratings

10   of various products to select a product that has the closest slider positions to what the user specified.

Fig. 5 presents an exemplary expanded functional block diagram of system 100. In Fig. 5, product recommendation unit 150 selects a product for recommendation according to both a pre-use selection specification, acquired by pre-use product selection specification

15   acquisition unit 110, and current multiple-scale ratings of products, retrieved from product multiple-scale rating storage mechanism 170. A recommendation product may be selected by maximizing the proximity between a pre-use selection specification and a current product rating. In doing so, the selected product best fits the properties of the desired product.

Once a recommended product is tried by a user, post-use multiple-scale rating

20   acquisition unit 130 acquires feedback from the user by collecting post-use ratings with respect to various rating scales. It should be noted that post-use ratings may also be independently acquired without the prior product recommendation and use stages. For

example, a on-line shopping service provider may simply conduct a survey on all the movie

products from volunteers on the web.

Fig. 6 presents an exemplary flowchart for a process that acquires post-use multiple-scale ratings. In Fig. 6, a product is identified at act 610 for which the post-use feedback is to

5   be acquired. For each identified product, post-use ratings on multiple scales may be collected

one by one through the loop from act 620 to act 660. A rating scale in each loop is

determined at act 620 and the post-use rating on the scale is acquired at act 630. The loop

continues until the ratings across all the scales are collected. This is determined at act 640.

The acquisition process shown in Fig. 6 also allow collecting post-use multiple-scale ratings

10   across different products. Whether proceeding to a different product is determined at act 650.

The acquired post-use multiple-scale ratings are saved at act 660 in post-use multiple-scale

rating acquisition unit 130.

In the illustrated system, shown in Fig. 5, acquired post-use multiple-scale ratings may

be fed to calibration unit 160 for calibration purposes. There may be various ways to utilize

15   the post-use multiple-scale ratings collected from users. For example, post-use ratings may be

used to simply understand the service quality of a product recommendation system. Various

statistics may be extracted from post-use ratings to characterize degree of satisfaction of

users. It is also possible to use post-use ratings, as feedback, to re-calibrate product

recommendation system 100 so that the service quality can be improved.

20   Post-use multiple-scale ratings from different individuals may be utilized to establish

personalized profiles so that product recommendation may be carried out in an individualized

manner to improve the service quality. Personalized profiles may include the information

about personal taste and may be used to construct individual filters that may be used, by

system 100, during recommending products to corresponding individuals so that the products can be selected according to personal taste.

Another example of using post-use multiple-scale ratings is to adapt the product ratings currently employed by system 100 based on post-use ratings. For example, a current

5   product rating may be updated according to the average post-use rating for the same product so that the new product rating is better tuned to the public perception of the product.

Yet one more example of utilizing post-use multiple-scale ratings is to adaptively adjust the decision making strategy of system 100 in selecting recommendation products. For example, according to users' feedback (post-use ratings), some of the rating scales (i.e.,

10   product properties) may seem more important to users or have bigger impact on users' satisfaction. Such rating scales may be detected by correlating post-use ratings in different scales with a satisfaction rating, also collected from users. In this case, it may be useful for system 100 to adopt a variable weighting scheme in product selection. That is, some of the ratings are treated more important than others.

15   In Fig. 5, calibration unit 160 may comprise, but is not limited to, three components: personalized profile generation unit 560, adaptive rating generation unit 570, and correlation unit 580.

Personalized profile generation unit 560 takes both pre-use selection specifications and the corresponding post-use multiple-scale ratings from a user to establish a personalized

20   profile for the user. A personalized profile may be constructed based on personal taste which may be identified by recognizing the pattern in which pre-use selection specifications differ from post-use ratings. Such a pattern may be recognized by observing the discrepancy

between what a user desires and what the user thinks what he/she gets across a plurality of

products.

Fig 7 illustrates an example of how personal taste with respect to a particular rating

scale may be identified using post-use ratings. There are a set of scales illustrated in Fig. 7,

5   each of which corresponds to one movie (product).. The exemplary scale in Fig. 7 applies to

movie products and is formed by two semantic differential words, comedy and drama. On

each scale, there are three sets of ratings (solid, hollow, and gray). A solid slider position

represents a pre-use selection specification from a user, a gray slider position represents the

current rating for a particular movie, and a hollow slider position represents the post-use

10   multiple-scale rating of the movie from the user. Using the three sets of ratings across

different movies, personal taste with respect to the illustrated rating scale can be identified

based on the discrepancy between pre-use selection specifications and post-use ratings. The

detected taste difference can then be used to calibrate product recommendation at an

individual basis.

15   When the user slides the scale to a solid slider position, it specifies the degree of

dramaness (or degree of comedy) of a desired product. Product recommendation system 100

uses such a specification to compare with the current product ratings on the same scale. The

movie that has the gray slider position (or rating) closest to the solid slider position is chosen

to be the recommendation. After the user reviews the movie, post-use rating is obtained as

20   the hollow slider position on the same scale. A large discrepancy between solid and hollow

slider positions indicates that the user may not get what is desired. If such a discrepancy is

consistent across different movies, it indicates that there may be a taste difference in this

particular user. For example, the post-use ratings in Fig. 7 are consistently to the right of pre-

use selection specifications. In this case, the user may be more comedy oriented (i.e., the user

considers more movies as drama than what the product ratings indicate

When a taste difference is identified, a personalized profile may be established that

characterizes the personal taste of a particular user in terms of how it deviates from current

5   ratings. A personalized profile for a particular user may be utilized to construct a filter to be

used by product recommendation system 100 to accordingly adjust future product

recommendations for this particular user on an individual basis.

Fig. 8 shows an exemplary flowchart for personalized profile generation unit 560. To

detect taste difference, pre-use selection specifications and post-use multiple-scale ratings

10   across a set of products are collected at acts 805 and 810. The difference between pre-use

product selection specifications and post-use ratings with respect to each scale is

characterized at act 820 and act 830. Such difference may be characterized in different ways.

For example, the differences on a particular scale across various products may be used to

form a difference vector. Alternatively, the differences on a particular scale across products

15   may be used to obtain a mean difference. Another example is to compute a median

difference.

Characterization of the discrepancy between pre-use selection specifications and post-

use multiple-scale ratings aims at describing the taste difference between a particular user and

current product ratings. The discrepancy characterization is used to build a personalized filter

20   at act 840. Such personalized profile is saved at act 850, together with other personalized

filters 585 (Fig. 5), so that product recommendation system 100 may use it to individualize

future recommendations for the corresponding user.

A different self-calibration functionality of system 100 may be to use post-use multiple-scale ratings to calibrate current product ratings. Current product ratings may be based on professional assessment of products, such as movie critics, or popular views, such as movie reviews from audience. Such ratings may change with time due to different reasons.

5   Recommendation quality may be affected by how closely the current ratings are consistent with users' views. Poor quality in recommending products causes users' dissatisfaction and may be reflected in post-use ratings. If quality degradation is due to difference in personal taste, service quality may be improved by applying personalized filters during product recommendation, as described earlier. When quality degradation is due to

10   changes in public perception about products, current ratings may need to adapt to such changes. This is achieved, in Fig. 5, by adaptive rating generation unit 570. Fig. 9 shows an example of how post-use ratings from multiple users may be used to calibrate a current rating.

In Fig. 9, the solid slider position represents a current rating of a movie on a scale formed by semantic differential words comedy and drama. The hollow slider positions

15   represent post-use ratings on the same movie from multiple users. When a substantial number of users produce post-use ratings that are significantly deviated from the current rating, it may indicate that the current rating needs to be re-calibrated. An adjustment to the current rating may be derived from the post-use ratings. For example, a mean post-use rating may be computed from the post-use ratings. This is illustrated in Fig. 9, in which the gray slider

20   position represents the mean post-use rating on the scale of comedy vs. drama. This mean post-use rating may be used directly to replace the current rating or to be combined with the current rating to derive an adjusted rating. A multiple-scale rating may be re-calibrated by individually adjust the rating of each and every scale.

Fig. 10 presents an exemplary flowchart of adaptive rating generation unit 570. A current multiple-scale rating for a product is obtained at act 1010 from product multiple-scale rating storage mechanism 170. Within the loops from act 1020 to act 1060 in Fig. 10, the current multiple-scale rating is re-calibrated, one scale in each loop. At act 1020, next scale to

5 be calibrated is selected as current scale. The post-use ratings with respect to the current scale from multiple users are retrieved at act 1030. These post-use ratings are used to derive a mean post-use rating at act 1040. An adjusted rating with respect to the current scale is obtained at act 1050 by re-calibrating corresponding current rating using the mean post-use rating. The adjusted ratings of all scales form an adjusted multiple-scale rating which is used,

10 at act 1070, to update the product rating in product multiple-scale rating storage mechanism 170. With current multiple-scale product ratings re-calibrated, future product recommendations may be made based on a multiple-scale rating that better fits with what users perceive. The service quality may subsequently improve.

When a product is recommended to a user, the acceptance of the recommended

15 product does not necessarily imply satisfaction. That is, a user may use a recommended product but may not be satisfied with the product. The dissatisfaction may not be caused by personal taste difference or out-of-date multiple-scale ratings. It is often desirable to identify exactly what attributes to users' disliking of recommended products.

Identifying the factors that attribute to users' dissatisfaction is different from detecting

20 the difference in personal taste or detecting the inconsistency between current ratings and users' perception. Whether a user is satisfied or dissatisfied with a recommended product may be viewed as an overall rating on the recommendation itself. The scale associated with such an overall rating may be described by semantic differential words "dislike" and "like".

A rating on this scale is also a post-use feedback. It should be noted that this post-use overall rating is not rated on products, as in the case of other scales described earlier, but rather on the recommendation.

To identify the cause of users' dissatisfaction may involve identifying the relationship between an overall degree of satisfaction (an overall rating) and various scales on which a product is rated. In other words, it is to identify which scales or which corresponding product properties drive users' dissatisfaction. In the illustrated embodiment shown in Fig. 5, correlation unit 580 identifies the product properties that attribute to users' dissatisfaction. Correlation unit 580 combines users' post-use overall ratings, with respect to the rating scale of dislike vs. like, and users' post-use multiple-scale ratings to perform self-calibration. Fig. 11 shows an exemplary relationship between post-use multiple-scale ratings and post-use overall dislike-like rating.

In Fig. 11, a plurality of post-use rating scales for movie products are shown, together with an additional overall rating scale. The example rating scales for movies are comedy vs. drama, modern vs. period, and adult vs. family. The overall rating scale is characterized by semantic differential words dislike and like. In Fig. 11, solid slider positions represent pre-use selection specifications and hollow slider positions represent post-use ratings. The gray slider position on the overall rating scale represents a post-use overall rating.

The discrepancy between a pre-use selection specification and corresponding post-use rating on a particular scale may be correlated with the overall rating. If a large discrepancy on a particular scale, for example on scale modern vs. period, consistently co-occurs with a low overall rating (dislike), it may indicate that the corresponding product property, associated with the scale of modern vs. period, may be an attributer to users' dissatisfaction.

Analyses, such as regression, may be performed to identify the rating scales or product

properties that drive dissatisfaction. The product properties that are identified as driving

factors of dissatisfaction may be accordingly re-calibrated. For example, system 100 may

adopt a product recommendation strategy, in which rating on individual scales are weighted

5   and the weights associated with the scales identified as driving factors to dissatisfaction may

be weighted higher. In doing so, the product recommendation system may be able to make

recommendations that are more sensitive to those attributing scales. Such weights may be

derived from analyzing the discrepancies between pre-use and post-use ratings, in relation to

the overall ratings.

10   Fig. 12 shows an exemplary flowchart of correlation unit 580. Post-use overall ratings

are acquired from users across products at act 1210. Corresponding post-use multiple-scale

ratings are acquired at act 1220. Discrepancies between pre-use product selection

specification and post-use ratings on every scale from every user are computed within the

loops from act 1230 to act 1240. Such computed discrepancies are analyzed, in relation to the

15   overall ratings, at act 1250, to identify the rating scales (corresponding to certain product

properties) that significantly attribute to users' dissatisfaction. Based on to such identified

causes, an adjustment filter is built at act 1260 and saved, at act 1270, in adjustment filters

590.

An adjusted filter may be implemented as, but not limited to, a set of weights

20   associated with multiple rating scales. As illustrated in Fig. 5., adjustment filters may be used

either to update current product ratings by applying the weights to individual scales (the link

from 590 to 170) or to be incorporated by product recommendation unit 150 in product

selection process (the link from 590 to 150) so that future product recommendation decisions can be made accordingly to minimize users' dissatisfaction.

The processing described above may be performed by a general-purpose computer alone or in connection with a specialized graphical processing computer. Such processing and

5   functionality can be implemented in the form of special purpose hardware or in the form of software being run by a general-purpose computer. Any data handled in such processing or created as a result of such processing can be stored in any memory as is conventional in the art. By way of example, such data may be stored in a temporary memory, such as in the RAM of a given computer system or subsystem. In addition, or in the alternative, such data may be

10   stored in longer-term storage devices, for example, magnetic disks, rewritable optical disks, and so on. For purposes of the disclosure herein, a computer-readable media may comprise any form of data storage mechanism, including such existing memory technologies as well as hardware or circuit representations of such structures and of such data.

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